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LETTER TO THE EDITOR

Behind the mask: Rethinking the use of face masks while exercising

Derrière le masque : repenser l'utilisation des masques lors de l'exercice

Case itself

There is an ongoing global effort against COVID-19 pandemic. As vaccination is applied globally (predominantly on at-risk populations), various measures such as temporary self-quarantine, social distancing, increased hand hygiene, and wearing a face mask (FM) proposed by the World Health Organization (WHO) and various governments worldwide are still in place as primary means of preventing further dissemination. In many instances, wearing a FM became mandatory when a person is in a closed space while being accompanied by others. Many individuals are therefore apprehensive in terms of maintaining their usual physical activity routines and staying safe in the midst of the outbreak. As a result, it is not uncommon to see individuals showing altruism and solidarity by wearing FM while exercising, even when local laws do not explicitly require it. Reasons for such behavior are multifactorial and go beyond the scope of this work. Still, it seems that individuals are more likely to wear FM due to the perceived predisposition and perceived severity of being affected by an infection, while perceived benefits of mask-wearing have a substantial effect on mask-wearing acquiescence [1]. Additionally, exercise setting (indoor/outdoor) can certainly be a decisive factor with respect to wearing a FM.

Discussion

Even though staying active is extremely important in the COVID-19 pandemic, wearing a FM while exercising remains a controversial topic. Some scientists have questioned the effectiveness of FM in terms of safety on the following grounds:

- there is limited data that they are really effective;
- empirical evidence showed that people are not wearing masks properly and consistently;
- masks can provide a sense of security where people can neglect other critical public health advice such as hand hygiene and social distancing;
- in some parts of the world there is a shortage of masks being available, and thus health-care workers should have a priority of using FM [2].

Although these are valid points, in the context of physical activity and mask-wearing, from a physiological point of view, the main issue is the physical barrier that the FM induces. Key factors to be considered when analysing the impact of FM on physiological respiration include the fabric mask is made of [(e.g. surgical masks (SM) are more permeable N95/FFP2 masks)], the exercise paradigm (aerobic, anaerobic, or a combination), its volume and intensity. In this context, gender may also play an important role as females have smaller airways and greater airflow resistance when compared to males, and this anatomical feature could represent a limiting factor, particularly during high-intensity exercise [3]. Furthermore, considering a potential increase in ventilation resistance and ventilatory work, wearing a FM while exercising might be especially challenging for smokers and individuals with long-term pulmonary obstructive diseases such as asthma and chronic obstructive pulmonary disorder.

Until recently, very few studies explored the physiological changes induced by wearing a FM. Initially, in 2005 Li and colleagues [4] focused on the effects of wearing N95 mask or SM on thermophysiological responses and the subjective perception of discomfort while performing intermittent exercise on a treadmill. The participants had significantly lower average heart rates (HR) when wearing SM as compared to N95 masks. Furthermore skin temperature and humidity were significantly lower by wearing SM compared to N95 [4].

In 2012, Roberge, Kim and Benson [5] studied the effects of low to moderate steady state exercise on a treadmill with and without SM. Over the course of 1 hour exercise, mild increases of HR, respiratory rate and transcutaneous carbon dioxide, without clinical relevance in healthy individuals, were detected. Moreover, SM were not subjectively

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perceived as being associated with discomfort or increased exertion while thermal discomfort of SM was reported only for the facial skin covered by the SM.

Due to high relevance of the topic in 2020, several studies have stressed the impact of wearing a FM while exercising. Fikenzer et al. [6] studied the effects of SM and N95 mask worn during incremental exercise compared to exercising without a FM. Wearing a mask was associated with a small decrease of the time to exhaustion compared when wearing a SM (-29 ± 40 s, $P = 0.07$, and a significant reduction when wearing a N95 mask (-52 ± 45, $P = 0.005$). Further, a large reduction in performance measured as maximal power (Pmax) and maximal oxygen uptake (VO_{2max}), and of dynamic pulmonary parameters (forced vital capacity, FVC $-8.8 \pm 6.0\%$ with SM and $-12.6 \pm 6.5\%$ with N95; forced expiratory volume in 1 s, FEV1 $-7.6 \pm 5.0\%$ lower with SM and $-13.0 \pm 9.0\%$ with N95) was observed. Importantly, participants reported increased discomfort consistently and significantly from SM to N95 masks with several-fold negative reports for the N95 compared to no mask and SM for breathing resistance.

Lassing et al. [7] published a study examining the effects of SM on cardio-pulmonary and metabolic responses during a steady state exercise. The authors reported that the airway resistance was two times higher with the SM than without the mask. Further, steady state exercise with SM compared with those without masks resulted in a significant increase in ventilation (77.1 ± 9.3 l min -1 vs. 82.4 ± 10.7 min -1; $P < 0.01$), oxygen uptake (33.1 ± 5 ml min -1 kg -1 vs. 34.5 ± 6 ml min -1 kg -1; $P = 0.04$), and HR 160.1 ± 11.2 bpm vs. 154.5 ± 11.4 bpm; $p < 0.01$). The average cardiac output tended to be greater with a SM (28.6 ± 3.9 l min -1 vs. 25.9 ± 4.0 l min -1; $P = 0.06$). No significant differences were found in blood lactate change, blood pressure, and rating of perceived exertion with and without masks. The authors concluded that higher HR observed in participants wearing SM might be attributed to cardiac compensation needed to meet oxygen demands posed by exercise in circumstances where airflow was partially obstructed.

Epstein et al. [8] investigated the effect of incremental exercise on a cycle ergometer performed without FM, with SM, and with N95 mask on various physiological parameters whereby each subject served as its own control. No significant differences were observed in terms of HR, respiratory rate, blood pressure, oxygen saturation, and time to exhaustion. However, exercising with N95 mask was associated with a significant increase in end-tidal carbon dioxide levels. The differences were more prominent as the load increased, reaching 8 mm Hg at exhaustion (none vs N95, $P = 0.001$).

A recent review by Hopkins et al. [9] has shown that the available data suggest that FM, including N95, SM and cloth FM have marginal and often undetectable effects on breathing rate and blood gases kinetics, even with maximal intensities.

It is important to outline that previously referred studies addressing the influence of FM wearing while exercising listed the consequences of its application during a single bout of exercise, it follows that these will likely arise during longer training regimen. To our knowledge, studies examining tolerance and possible adaptations to wearing a FM while exercising over a longer period of time have not been published yet. Knowing the adaptive abilities of the human body, proper adjustments will certainly occur, but the potential for achieving peak performance will likely be hindered [6].

The purpose of this letter is not to deny the important role FM play in combating COVID-19 pandemic, but rather to scientifically address possible effects of wearing a mask while exercising in non-COVID-19 affected individuals. This issue has been recently underlined by the WHO suggesting that people should not wear FM while exercising as they may reduce the ability to breathe comfortably, and even promote the growth of microorganisms [10]. Literature analysis shows conflicting data with respect to the use of FM and its influence on physiological parameters during exercise. To avert confusion and appease both performance and safety, reusable high-flux (high permeability) masks, that are affordable, easy to maintain, offer minimal impact on performance and a fair level of safety, might be the solution for indoor activities, when adequate physical distancing is not guaranteed. This can be a temporary solution until majority of population is vaccinated or herd immunity is reached. Meanwhile, exercising outdoors, without a FM, might be the best advice as it is associated with a reduced risk of transmission compared to indoor activities and at the same time there is no breathing barrier.

In addition, this is a call for researchers to further explore this issue in more depth, since it is extremely relevant in present times. Novel studies examining the effects of FM wearing while exercising cited in this letter have predominantly been performed in young and healthy individuals and thus it would be interesting to see abovementioned effects in other subsets of the general population. Dedicated research is needed to unravel these issues as people devoted to sports and physical activity are longing for such important information.

Disclosure of interest

The authors declare that they have no competing interest.

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